AGRICULTURAL NEWS LETTER

VOL. 9 - NO. 6 NOVEMBER-DECEMBER, 1941

This publication contains information regarding new developments of interest to agriculture based on laboratory and field investigations of the du Pont Company and its subsidiary companies. It also contains published reports and direct contributions of investigators of agricultural experiment stations and other institutions as related to the Company's products and other subjects of agricultural interest.

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ISSUED BY PUBLIC RELATIONS DEPARTMENT, E. I. DU PONT DE NEMOURS & CO. (INC.), WILMINGTON, DEL.

Vol. 9 - No. 6 Nov.-Dec. 1941

AGRICULTURAL NEWS LETTER

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CONTENTS

	Page
CHRISTMAS GREETING	80
Research Develops Nylon Brushes for Dairy Industry	81
Plastic Wood	82
Timber Treated With Chromated Zinc Chloride	87

A Merry Christmas

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As we go to press with this issue of the "AGRICULTURAL NEWS LETTER", the Christmas Season is rapidly approaching, and everybody is occupied with plans for as happy a holiday season as the war will permit.

Many problems loom large on the horizon for the coming year. While giving our all for the defense of our land, let's sail into the spirit of Christmas with our old "V" - "V" - "V" (vim, vigor and vitality) with an "all out" for V I C T O R Y in 1942.

Meantime we want to take this opportunity to say "MERRY CHRISTMAS AND A HAPPY AND PROSPEROUS NEW YEAR" to our readers.

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RESEARCH DEVELOPS NYLON BRUSH FOR DAIRY INDUSTRY

EDITOR'S NOTE: Results of experimental work in the laboratory and under actual conditions have proved the worth of nylon-bristled brushes to the dairy industry for use in bottle washing and pipe, cooler, and sanitary tube cleaning. As a result of this research, the Du Pont Plastics Department recently announced that the new brushes are now available in many sizes and shapes. They are made by several manufacturers who obtain from Du Pont the nylon filament for bristling.

The application of nylon-bristled brushes to the dairy is another step in the increasing industrial use of this material. Nylon brushes already are serving the textile, brewing, electroplating, cleaning, and bottling industries, and research is developing new brushes for other fields.

Nylon filament has relieved dairy brush manufacturers of dependence on imported material, especially Oriental hog bristle, supplies of which have been very uncertain.

Nylon-bristled brushes will aid in sterilizing the 3,600,000,000 milk bottles which, it is estimated, are washed each year in brush machines. They are available for other cleaning operations in the meticulous dairy industry, and new types, shapes and sizes are being developed.

A milk bottle brush washer contains two rows of rotary inside brushes with from two to ten brushes per row. Two larger rotary brushes clean the outsides of the bottles as they move past.

Brushes bristled with nylon, in actual tests, have lasted three to four times longer than those with natural bristles. One large eastern plant reported no wear on nylon brushes after four months of daily use. The longevity of these brushes more than compensates for their slightly higher initial cost.

The moisture absorption of nylon bristle is only 20 per cent that of hog bristle, allowing the nylon to retain stiffness and avoid limp and soggy aspects after long hours of continuous use in fluids.

Nylon dairy brushes have shown resistance to mild acid and alkali solutions. Further, they are not affected by boiling water and can be sterilized after each use.

Manufactured in mechanically controlled diameters, nylon bristles resist abrasion and do not fray or split. They stand up exceptionally well under the constant flexing and whirling involved in high speed washing of milk bottles.

The monofilament, which is nylon in diameters above five one-thousandths of an inch, is chemically the same as the gossamer-fine yarn for sheer nylon hosiery.

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Agricultural News Letter (Du Pont)
Vol. 9 No.6 Nov.-Dec.1941.

PLASTIC WOOD

EDITOR'S NOTE: So much interest has been shown in plastic wood for National Defense as well as normal industrial uses, that the United States Department of Agriculture Forest Products Laboratory, in cooperation with the University of Wisconsin, in October released a mimeographed bulletin on the subject. This statement, prepared by W. K. Loughborough, emphasizes the plasticizing properties of urea and also deals with the mechanics of successfully bending treated wood. It is reproduced here by permission.

Discovery of the wood plasticizing properties of urea, a synthetic low-cost chemical, has opened a new field of plastic wood research at the Forest Products Laboratory. Since the original discovery, two different lines of experimentation have been followed in developing the possibilities of the new treatment. Simple impregnation of wood with urea, followed by drying and bending with the aid of heat, comprises one branch of investigation. A second line of research has involved more complex factors and, by overcoming certain possible defects inherent in the simple urea treatment, has resulted in a markedly different product. Both phases of the research, so far as it has been possible to develop them, are herewith described.

It should be emphasized, however, that in both phases development has not proceeded beyond the laboratory stage of experimentation. No commercial applications have been made. No products manufactured by use of the urea treatments are on the market. Applications for patents are pending. When granted, licenses for their free use by citizens of the United States may be granted by the Secretary of Agriculture.

SIMPLE IMPREGNATION WITH UREA

Solid Wood

The original disclosure that wood becomes plastic upon soaking with a solution of urea came as a result of experiments in chemical seasoning of wood at the Forest Products Laboratory. It was found that 1-inch oak squares so soaked, and subsequently dried, became plastic and easily bendable with the hands upon application of heat. With cooling, the bent wood became rigid again, retaining its new shape.

Essentially, the simple urea treatment involves nothing more than this procedure. A technic worked out for its application on a laboratory scale can be adapted easily to other conditions, such as the home workshop or small wood working plant.

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Green wood is required for treatment. A solution of urea crystals in water is formed, using equal amounts by weight of water and the chemical. The wood is placed in this solution for a length of time that varies with the species being plasticized. Investigation of this and other factors involving plasticization of different species with urea is now under way. Red and white oaks, for example, have been experimented with as well as such softwoods as Sitka spruce and bigberry juniper. For oak, the soaking period may be generally stated as 10 days for each inch of thickness — the time needed for absorption of an amount of urea equal to 25 per cent of the oven-dry weight of the wood.

The drying time needed likewise varies with the drying temperature used, wood species, and the like. In no case, however, should the temperature be higher than 140°F., and for oak it should not exceed the optimum kiln temperature of 115°F. Temperatures higher than 140°F. will cause the urea to dissociate and thus destroy its plasticizing effects. The drying time for urea-soaked wood is less than that of untreated wood going through the same moisture content changes; for example, if the seasoning period of 3-inch Sitka spruce is 30 days, this time can be reduced to 15 days with urea-impregnated wood. This accelerated drying rate in the kiln is brought about by more severe drying conditions permitted by the treatment and should largely offset the time consumed by the soaking process.

When properly dried, the wood is ready for heating and bending. A temperature range of from 212° to 220°F. is the optimum for bending operations. Thin wood — plywood, for example — can be twisted to the desired shape easily by hand. For larger pieces, mechanical aids to bending are necessary. Properly designed equipment will give much sharper bends than can be achieved with standard steam bending methods, and with far less breakage to stock.* Best bending results will be obtained if, after drying, temperature of the wood is raised to the optimum temperature for bending by boiling in the regular urea solution for a period of 15 or 20 minutes per inch of thickness. Good bending can, however, be accomplished by heating the dry treated wood to the desired temperature in dry air. Upon cooling, the wood, as stated earlier, will retain its new shape, provided it is dried to a sufficiently low moisture content before bending. In some cases, as in thick stock, it is desirable to predry to a relatively high moisture content of 25 to 30 per cent. In this event the bent products will have to be dried somewhat after bending in order to preserve the desired shape.

Sawdust

Urea impregnation can also be applied to sawdust for the formation of solid sheets or panels. It is necessary, however, to use considerable pressure in the molding operation. For this, machinery is needed.

The compressing technic employed by the Laboratory for sawdust molding consisted of the following steps:

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*See "Wood Bending (Oct. 1929) with Appendix (1941) on Apparatus for Bending Boat Ribs," by T. R. C. Wilson. U. S. Forest Products Laboratory Mimeograph R966.

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1. Determine oven-dry weight of sawdust.
2. Add dry urea — 25 per cent by weight of the sawdust.
3. Add enough water to make of the mass a paste.
4. Dry the sawdust mix to moisture content of 2 to 3 percent.
5. Add a suitable lubricant, such as 1 to 5 per cent zinc stearate, to the mix.
6. Place mix in mold.
7. Exert pressure of 1,000 to 1,500 lbs. per sq. in.
8. Raise press temperature to 180–185°C.
9. Subject to temperature-pressure 3 to 5 minutes.
10. Cool under pressure by running water through press platens.
11. When cooled to 60°C., remove product from press.

The technic used here is not necessarily the optimum for all conditions of pressing, nor the only way pressing can be done. Products manufactured at the Laboratory by following these steps were, however, of good strength properties.

Certain qualities of the finished product should not be overlooked. For example, molded material is not so resistant to water as is ordinary untreated wood. It will withstand soaking for a comparatively few hours before losing strength through disintegration. Its water resistant properties can be greatly improved by the addition of such chemicals as furfural, carbon tetrachloride, or thiourea.

Properties of the Product

Solid Wood

From limited tests it seems that lumber or dimensional stock impregnated by the simple urea treatment has strength properties about equal to those of the normal untreated wood. In color it is characteristically gray or black. It can be handled and used about as ordinary wood is used.

Sawdust

Molding of the urea-impregnated sawdust in a hot press results in considerably changed properties. The color is black or gray. The material becomes so hard that it is often difficult to nail. Sawing and machining properties are good. Veneer facings can be applied, but some work will be required to perfect suitable glues. The material is noncorrosive so far as metal fastenings are concerned. Tests thus far made indicate that strength qualities of the treated, compressed sawdust are comparable to other common plastics.

Limitations

Two important deficiencies affect the usefulness of wood so treated, however, whether it be solid wood, sawdust, or chips. One of them has already been mentioned with relation to compressed sawdust — its poor water resistance. Impregnation with urea, in fact, actually increases the hygroscopicity of wood unless the soaking solution be modified with chemicals which increase water

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resistance. The other deficiency involves the return of the material to a plastic condition when reheated to 212°F. Softened thus, it tends to lose shape in response to any pressures or stresses it may be under.

These two deficiencies naturally place limitations upon the practical usefulness to which the simple urea treatment can be turned. Laboratory scientists are therefore inclined to regard it as more important from a scientific than from a commercial standpoint. The significance of the fact that urea plasticizes wood is an interesting development in the study of basic wood properties. Wide commercial applications are not expected, however, because of the thermoplastic nature of the complex and because urea tends to darken wood and increases its hygroscopicity. Conceivably, however, the process may have some important uses where these properties are not objectionable.

THERMOSETTING PROCESS

The twin problems of preventing resoftening of bent urea-treated wood and improving its water resistance were in great degree solved by addition of other chemicals to the soaking solution, notably formaldehyde. It was found that this substance, uniting chemically with urea within the wood cells, formed a synthetic resin which largely sealed the wood against water. Swelling and shrinkage were thereby materially reduced. As soon as the resin was set by heat (polymerized), the wood assumed a stiffness which could not be affected by subsequent heating, at least to 300°F. It thus became permanently thermoset.

A formula developed at the Laboratory for a treating solution which accomplished these results is:

380	parts of	urea
344	" "	formaldehyde (37 per cent solution)
231	" "	water
6	" "	sodium hydroxide
39	" "	borax
1,000		

All proportions in this formula are by weight. To the solution was added 10 parts of glacial acetic acid as it is essential that the above formula be slightly acid. To obtain good diffusion into the wood before the resin-forming action of the formaldehyde and urea takes place, this chemical reaction must be retarded. The borax is used for this purpose. The soaking period necessary to get complete diffusion of the chemicals within the wood is about the same as that for the simple urea solution.

From this point on the steps necessary in the entire bending and molding process are different. After the treated wood is removed from the solution, it must be heated to about 212°F., preferably in a boiling aqueous solution of urea, and then promptly bent to the desired shape. Under such conditions the bending properties are as good as those of urea-treated wood. If the bending is not done promptly, resin will begin to form and the plasticity of the wood will decrease. When this happens, reheating will be of no avail in resoftening it. The wood is then dried in an oven, kiln, or by simple exposure to air, after which it is heated to about 300°F. in order to polymerize the thermosetting, resin-forming chemicals.

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Properties of the Product

Because of its recent development, experimentation with the materials produced by the process has necessarily been limited. All the properties of the new wood substance have been by no means established. In general, however, the tests made thus far indicate that the strength qualities are not materially affected by temperatures up to the boiling point of water, and can be said to be about the same as those of normal wood and of the simple urea-treated thermoplastic wood at room temperatures. It is stiffer, that is, it does not bend as much as normal wood, under the same load. It is considerably harder. Unlike urea treatment, the urea-aldehyde treatment tends to bleach rather than to darken the wood.

GENERAL

The mechanics of successfully bending wood treated by either method depends largely upon good technic in handling properly designed apparatus, as mentioned earlier. As yet, research has not been carried far enough to establish the shortest radius upon which wood of a given thickness may be bent. Stock 1-1/2 inches thick has been bent through 180 degrees on an inside radius of 5 inches, and 1/4 inch stock was similarly bent on a radius of 3/4 inch. While this degree (3/4 inch) of upset is not necessarily the maximum obtainable, it will be noted that the ratio of the length of the inside radius to the thickness of the stock is about 1:3 in both instances. It can be assumed, however, that thicker wood requires a proportionately longer radius.

It has not yet been possible to establish whether the treatment adds to the resistance of wood to destructive insect and decay attack.

To date research has been carried out only on a limited number of wood species. It appears, however, that the hardwoods respond better than do softwoods to both processes. Of the hardwoods, gum and oak give better results than the other species tried.

Urea, the synthetic chemical which is relatively the basis for this plasticizing treatment, is manufactured commercially by combining liquid carbon dioxide and liquid ammonia under pressure. It is commonly sold in granular form at $80 to $90 a ton. It is not sold by the manufacturers in quantities less than 100 pounds.

It should be pointed out to those interested in undertaking commercial applications of either process that existing limitations upon domestic sales of such chemicals as formaldehyde, and of pressure machinery, molds, dies, etc., caused by the National Defense program must be taken into consideration.

TIMBER TREATED WITH CHROMATED ZINC CHLORIDE

EDITOR'S NOTE: In the preceding article, the wood-plasticizing and wood-bending properties of urea are discussed in some detail. The discovery of these properties of this low-cost, synthetic chemical has, as indicated, opened a new field of plastic wood research. Below is a report of another highly successful process — treatment of wood with chromated zinc chloride to protect the wood from decay and termite attack and to reduce the fire hazard of structures in which the treated wood is used. This development is also of considerable importance in the National Defense program and, in addition, offers what amounts to "a new material for peacetime application."

From Canada comes news that a huge Boeing Aircraft Plant at Vancouver has reached completion. The announcement made by the October 9 issue of "Engineering News-Record" carries several important facts which merit more than passing attention. The "News-Record" editorial begins thus:

> "Canada has given the builders of this country a fine example of how to meet the structural steel shortage by the use of timber and of how to conserve transportation by the wide employment of local materials. In planning a great structure for the manufacture of flying boats in British Columbia, the designers specified treated timber for the frame and roof trusses and plywood and wood-framed sash* for the exterior walls. Now that the structure is completed, it appears that little could have been gained by using steel if no emergency had existed."

In addition to conserving a needed metal and reducing demands upon transportation, another point that will bear emphasizing is the speed of construction that treated timber permits. Timber was preframed at the mill and afterwards treated, so the account states, aiding greatly in the speedy assembly of the 128-foot roof trusses at the rate of five per eight-hour shift.

A total of 3,000,000 board feet of timber impregnated with chromated zinc chloride entered into the construction of this vital airplane plant. Timber so treated is protected against decay and termite attack, is clean, odorless and may be painted.

*untreated

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Since the beginning of the wood preserving industry, design engineers, architects, lumber producers and manufacturers of approved wood preservatives have been pointing out that treated wood is in a class by itself as a structural material for permanent construction. It should not be regarded, these authorities insist, as ordinary timber, for it combines with the inherent advantages of wood as a building material the added quality of assured durability. It is as distinctive in class or kind as steel and concrete. Moreover, it is, to a worthwhile degree, fire resistant.

Fire Hazard Reduced

The timber constructed airplane plant taught a further lesson. The editorial continues:

> "Chemical treatment of the timber gives new values in durability, and in the light of the full-scale fire-test, it appears that the fire hazard is much less than might be expected."

The fire test referred to occurred when the plant was near completion. Fire broke out in a two-story wooden office building only thirty feet from the main plant building with the exterior plywood finish, states the "Engineering News-Record." At that time fire protection depended upon chemicals on hand and city service. Before the fire fighting apparatus could be brought to the plant, the main building had been exposed 45 minutes to a fiercely burning fire. When a hose was brought into play, the plywood sheathing had entirely burned, but the charring of the treated truss and column timbers was no deeper than 3/8 of an inch.

To quote the "News-Record" further on the fire:

> "The fire gave considerable confidence in the ability of a structure of this type to resist fire. A very serious loss might have resulted if the structure had been inclined to burn readily. The treated timbers did not readily spread the conflagration.
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> "This building and others in our own country emphasize that timber* is not only a defense material of first rank, but that modern practices in its manufacture and use offer the designer what is, in effect, a new material for peace-time application."

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*treated